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(54) Lubricant compositions.

(57) Lubricant compositions for use in traction drives are disclosed which incorporate a selected hydrocarbon type of base oils combined with specified amounts of selected zinc dialkyldithio phosphates, alkenyl succinimides or their boron derivatives, carboxylic acid esters of polyalcohols. These compositions provide traction drive apparatus with prolonged fatigue life, high oxidation stability, high shear stability, high traction coeffeicient, high wear resistance and rust-proofness.

EP 0 208 541 A2

LUBRICANT COMPOSITIONS

This invention relates to fluid compositions suitable for use in traction drives.

Traction drive devices such as of ball-cone, cone-ring, wheel-disc, chain-sieve, toroidal and planetary roll types are designed to operate with power transmission that takes advantage of the rolling friction which develops as a result of a film of oil being hardened at the contacting surfaces. In general, lubricating oils for use in those traction drives should meet the following requirements.

1. High coefficient of traction.

2. Enhanced oxidation stability, hence freedom from sludge formation and high shear stability.

3. Rust-proofness to prevent pitching and flaking at the contacting surfaces of the traction wheel.

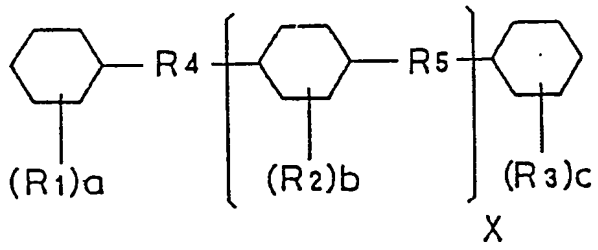
4. High wear resistance to permit sufficient lubrication of bearings, wheels and actuators.

Known traction fluids are satisfactory in part, not in whole of the above requirements. Various additives have been proposed to compensate for the missing qualities. However, the use of such additives has in many instances resulted in reduced fatigue life of traction wheels, bearings and gears and also reduced traction coefficient.

It has now been found that fluid compositions of superior characteristics can be obtained for use in traction drives which incorporate a selected class of hydrocarbon compounds combined with certain dialkyldithio-zinc phosphates, alkenyl succinimides or their boron derivatives, and carboxylates of polyalcohols.

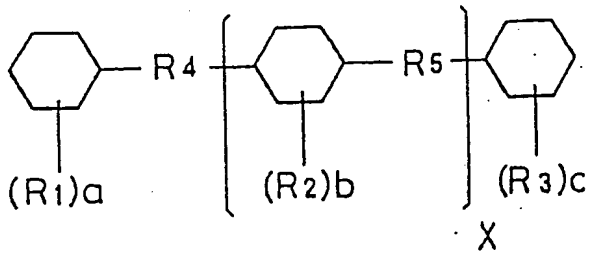
It is therefore the primary object of the present invention to provide improved traction fluid compositions which are capable of providing traction drive apparatus with prolonged fatigue life, high wear resistance, high traction coefficient, high oxidation and shear stability, rust-proofness and other characteristics desired to attain best traction performance.

According to a first aspect of the invention, there is provided a lubricant composition for use in traction drives comprising: a base oil represented by the formula



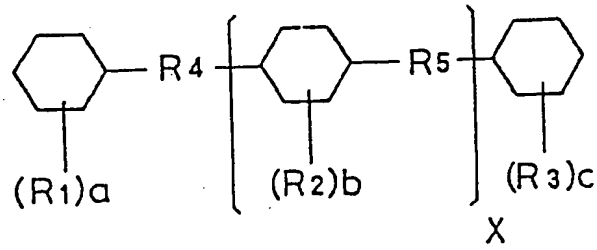
where R_1, R_2 and R_3 are alkyl groups of 1 -4 carbon atoms, R_4 and R_5 are methylene, ethylene or trimethylene groups which may be substituted at the hydrogen atoms with an alkyl group of 1 -4 carbon atoms, a, b and c are integers of 0 -2, and x is an integer of 0 or 1; [I] a zinc dialkyldithio phosphate in an amount of 0.1 -5 wt. %; [II] an alkenyl succinimide or its boron derivative in an amount of 0.1 -5 wt. %; and [III] a carboxylic acid partial ester of a polyalcohol of 3 -6 carbon atoms in an amount of 0.01 -5 wt. %, each of the amounts being based on the total composition.

According to a second aspect of the invention, there is provided a lubricant composition for use in traction drives comprising: a base oil represented by the formula



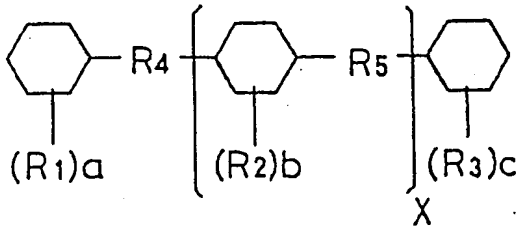
where R_1, R_2 and R_3 are alkyl groups of 1 -4 carbon atoms, R_4 and R_5 are methylene, ethylene or trimethylene groups which may be substituted at the hydrogen atoms with an alkyl group of 1 -4 carbon atoms, a, b and c are integers of 0 -2, and x is an integer of 0 or 1; [I] a zinc dialkyldithio phosphate in an amount of 0.1 -5 wt. %; [II] an alkenyl succinimide or its boron derivative in an amount of 0.1 -5 wt. %; [III] a carboxylic acid partial ester of a polyalcohol of 3 -6 carbon atoms in an amount of 0.01 -5 wt. %; and [IV] a polyolefin in an amount of 0.1 -20 wt. %, the polyolefin resulting from the homo-or co-polymerization of olefins of 2 -8 carbon atoms and having an average molecular weight of 200 -10,000, each of the amounts being based on the total composition.

According to a third aspect of the invention, there is provided a lubricant composition for use in traction drives comprising: a base oil represented by the formula



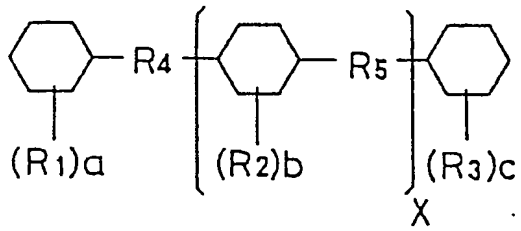
where R_1, R_2 and R_3 are alkyl groups of 1 -4 carbon atoms, R_4 and R_5 are methylene, ethylene or trimethylene groups which may be substituted at the hydrogen atoms with an alkyl group of 1 -4 carbon atoms, a, b and c are integers of 0 -2, and x is an integer of 0 or 1; [I] a zinc dialkyldithio phosphate in an amount of 0.1 -5 wt. %; [II] an alkenyl succinimide or its boron derivative in an amount of 0.1 -5 wt. %; [III] a carboxylic acid partial ester of a polyalcohol of 3 -6 carbon atoms in an amount of 0.01 -5 wt. %; and [V] at least one of molybdenum dithiophosphates and molybdenum dithiocarbamates in an amount of 0.1 -10 wt. %, each of the amounts being based on the total composition.

According to a fourth aspect of the invention, there is provided a lubricant composition for use in traction drives comprising: a base oil represented by the formula



where R_1, R_2 and R_3 are alkyl groups of 1 -4 carbon atoms, R_4 and R_5 are methylene, ethylene or trimethylene groups which may be substituted at the hydrogen atoms with an alkyl group of 1 -4 carbon atoms, a, b and c are integers of 0 -2, and x is an integer of 0 or 1; [I] a zinc dialkyldithio phosphate is an amount of 0.1 -5 wt. %; [II] an alkenyl succinimide or its boron derivative in an amount of 0.1 -5 wt. %;[III] a carboxylic acid partial ester of a polyalcohol of 3 -6 carbon atoms in an amount of 0.01 -5 wt. %; and [IV] a polyolefin in an amount of 0.1 -20 wt. %, the polyolefin resulting from the homo-or co-polymerization of olefins of 2 - 8 carbon atoms and having an average molecular weight of 200 -10,000; and [V] at least one of molybdenum dithiophosphates and molybdenum dithiocarbamates in an amount of 0.1 -10 wt. %, each of the amounts being based on the total composition.

Base oils suitable for the purpose of the present invention are hydrocarbon compounds represented by the formula

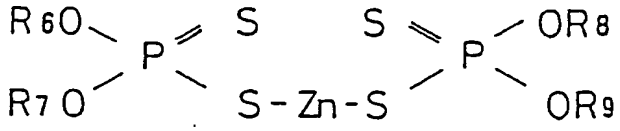


where R_1, R_2 and R_3 are alkyl groups of 1 -4 carbon atoms, R_4 and R_5 are methylene, ethylene or trimethylene groups which may be substituted at the hydrogen atoms with an alkyl group of 1 -4 carbon atoms, a, b and c are integers of 0 -2, and x is an integer of 0 or 1.

Eligible substituting groups for R_1, R_2 and R_3 are methyl, ethyl, propyl and butyl, amongst which methyl and ethyl are particularly preferred. Eligible R_4 and R_5 groups are methylene, methylmethylene (ethylidene), dimethylmethylene, ethylene, methylethylene, 1,1-dimethylethylene, 1,2-dimethylethylene, 1,1,2-trimethylethylene, tetramethylethylene, trimethylene, 1-methyltrimethylene, 2-methyltrimethylene, 1,1-dimethyltrimethylene, 1,2-dimethyltrimethylene, 1,3-dimethyltrimethylene, 2,2-dimethyltrimethylene, 1,1,2-trimethyltrimethylene, 1,1,3-trimethyltrimethylene, 1,2,2-trimethyltrimethylene, 1,2,3-trimethyltrimethylene, 1,1,2,2-tetramethyltrimethylene, 1,1,2,3-tetramethyltrimethylene, 1,1,3,3-tetramethyltrimethylene and 1,2,2,3-tetramethyltrimethylene.

Specific examples of the base oils include dicyclohexylmethane, 1,1-dicyclohexylethane, 1,2-dicyclohexylethane, 1,2-dicyclohexylpropane, 1,3-dicyclohexylpropane, 2,2-dicyclohexylpropane, 1,2-dicyclohexyl-2methylpropane, 1,3-dicyclohexylbutane, 1,3-dicyclohexyl-3-methylbutane, 1,3-dicyclohexyl-2,3-dimethylbutane, 2,3-dicyclohexyl-2,3-dimethylbutane, 2,4-dicyclohexylpentane, 2,4-dicyclohexyl-2-methylpentane, bis-(cyclohexylmethyl)cyclohexane, bis(1-cyclohexylethyl)cyclohexane and bis(1-methyl-2-cyclohexylethyl)cyclohexane, substituted compounds thereof in which one or two methyl or ethyl groups are bonded to the hydrogen atoms of the cyclohexyl ring, and combinations thereof. Particularly preferred among those base oils are 1-cyclohexyl-1-methylcyclohexylethane, 1-cyclohexyl-1-ethylcyclohexylethane, 1-cyclohexyl-1-dimethylcyclohexylethane, bis(1-cyclohexylethy)-methylcyclohexane, bis(1-cyclohexylethyl)-ethylcyclohexane, bis(1-cyclohexylethyl)-dimethylcyclohexane and 2,4-dicyclohexyl-2-methylpentane, and combinations thereof.

Zinc dialkyldithio phosphates useful as component [I] hereunder are compounds represented by the formula



where R_6, R_7, R_8 and R_9 are alkyl or alkylaryl groups having a carbon number of 3 -22, preferably 3 -15, and may be the same or different. Particularly preferred alkyl and alkylaryl groups are isopropyl, sec-butyl, isobutyl, n-amyl, isoamyl, 4-methylpentyl, 2-ethylhexyl, decyl, isodecyl, nonylphenyl and dodecylphenyl.

The amount of component [I] to be added should be in the range of 0.1 - 5 wt. %, preferably 0.5 -3 wt. %, based on the total composition. Smaller amounts than 0.1 wt. % would fail to give sufficient wear resistance and oxidation stability. Greater amounts than 5 wt. % would result in reduced rolling fatigue life and traction coefficient.

Alkenyl succinimides and their boron derivatives are useful as component [II[in the invention. The alkenyl succinimides may be obtained by reaction of polyolefins with maleic anhydride and by subsequent conversion of the resulting intermediates into the form of imides by reaction with amines. Examples of the polyolefins are those resulting from the homo-and co-polymerization of olefins of 2 -30 carbon atoms such as ethylene, propylene, butene, pentene, hexene, heptene, octene, nonene, decene and dodecene, and also from the co-polymerization of those olefins with aromatic olefins such as styrene. The molecular weight of the polyolefins is between 300 and 5,000. Examples of the amines to be here used include monoamines such as methylamine, ethylamine, propylamine, butylamine, pentylamine, hexylamine, heptylamine and octylamine, polyamines such as ethylenediamine, propylenediamine, N,N'-dimethylpropylenediamine, trimethylenediamine, N,N-dihexyltrimethylenediamine, decamethylenediamine, di-(trimethylene)triamine, di(heptamethylene)triamine, triethylenetetraamine, tripropylenetetraamine, tetraethylenepentaamine, pentaethylenehexaamine, imidazoline, methylimidazoline, bis(aminoethyl)-imidazoline, pyrimidine, aminopropylpiperazine and bis(aminoethyl)piperazine, and hydroxy-substituted amines such as N-mono(hydroxyethyl)-ethylenediamine, N,N'-bis(hydroxyethyl)-ethylenediamine, N-mono(hydroxypropyl)-diethylenetriamine and N,N'-bis(hydroxypropyl)-tetraethylenepentaamine.

The borides or boron derivatives of the above alkenyl succinimides are obtainable by reaction of such succinimides with boron compounds selected for example from boron oxide, boron oxide· hydrates, boron trifluoride, boron trichloride, boron tribromide, alkyl or aryl borons, boric acid, metaboric acid and tetraboric acid, esters of these boric acids with alcohols and phenols and ammonium salts thereof. The boron derivatives may be synthesized by numerous methods disclosed for example in U. S. Patent Nos. 3,281,428, 3,282,955, 3,284,410, 3,284,409, 3,344,069 and 3,533,945, Japanese Patent Publication Nos. 42-8013, 42-8014, 47-45161 and 47-45162, and Japanese Patent Application (Kokai) Nos. 51-52381, 51-130408 and 54-87705.

The amount of component [II] to be added should be in the range of 0.1 -5 wt. %, preferably 0.5 -3 wt. %, based on the total composition. Smaller amounts than 0.1 wt. % would invite insufficient oxidation stability. Greater amounts than 5 wt. % would result in reduced rolling fatigue life, traction coefficient and wear resistance.

Carboxylic acid partial esters of polyalcohols of 3 -6 carbon atoms are useful as component [III] in the invention. Examples of the polyalcohols include glycerine [$C_3H_5(OH)_3$], pentaerythritol [$C_4H_8(OH)_4$], sorbitol [$C_6H_8(OH)_6$] and sorbitan [$C_6H_8O(OH)_4$]. Examples of the carboxylic acids are those having a carbon number of 8 -22, preferably 12 -18, and including decanoic acid (capric acid), undecanoic acid, dodecanoic acid (lauric acid), tridecanoic acid, tetradecanoic acid (myristic acid), pentadecanoic acid, hexadecanoic acid (palmitic acid), heptadecanoic acid (margaric acid), octadecanoic acid (stearic acid), nonadecanoic acid, eicosanoic acid (arachidic acid), heneicosanoic acid, decosanoic acid (behenic acid), dodecenoic acid, tetradecenoic acid, hexadecenoic acid, octadecenoic acid (oleic acid), dodecadienoic acid, tetradecadienoic acid, hexadecadienoic acid and octadecadienoic acid (linoleic acid).

Specific examples of component [III] include glycerine dodecanoic acid monoester - (monoglyceride laurate), glycerine hexadecanoic acid monoester (monoglyceride palmitate), glycerine octadecanoic acid monoester (monoglyceride stearate), glycerine octadecenoic acid monoester - (monoglyceride oleate), pentaerythritol dodecanoic acid monoester (pentaerythritol monolaurate), pentaerythritol hexadecanoic acid monoester (pentaerythritol monopalmitate), pentaerythritol octadecanoic acid monoester (pentaerythritol monostearate), pentaerythritol octadecenoic acid monoester (pentaerythritol monooleate), sorbitol dodecanoic acid monoester (sorbitol monolaurate), sorbitol hexadecanoic acid monoester (sorbitol monopalmitate), sorbitol octadecanoic acid monoester (sorbitol monostearate), sorbitol octadecenoic acid monoester (sorbitol monooleate), sorbitan dodecanoic acid monoester (sorbitan monolaurate), sorbitan hexadecanoic acid monoester (sorbitan monopalmitate), sorbitan octadecanoic acid monoester (sorbitan monostearate), sorbitan octadecenoic acid monoester (sorbitan monooleate), sorbitan octadecanoic acid triester - (sorbitan tristearate) and sorbitan octadecenoic acid triester (sorbitan trioleate), and combinations thereof.

The amount of component [III] to be added should be in the range of 0.01 -5 wt. %, preferably 0.1 -3 wt. %, based on the total composition. Smaller amounts than 0.01 wt. % would be insufficient for rust-proofness. Greater amounts than 5 wt. % would induce reduced rolling fatigue life and traction coefficient.

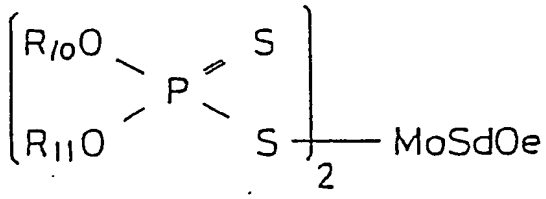
A first embodiment of the invention provides lubircant compositions in which components [I] to -[III] are combined with base oils. According to a second embodiment of the invention, selected polyolefins are further incorporated to build dynamic viscosity and shear stability.

Polyolefins eligible as component [IV] hereunder are those having an average molecular weight of 200 -10,000, preferably 1,000 -4,000, and obtained by the homo-and co-polymerization of olefins selected for example from ethylene, propylene, 1-butene and isobutylene with use of a Friedel-Crafts catalyst such as aluminum chloride, magnesium chloride, boron fluoride or titanium tetrachloride, or a complex compound thereof, if necessary in combination with a co-catalyst such as an organic halide or hydrochloric acid. Polybutene, polyisobutylene, ethylene-propylene copolymer, ethylene-1-butene copolymer and ethylene-propylene-1-butene copolymer are particularly preferred.

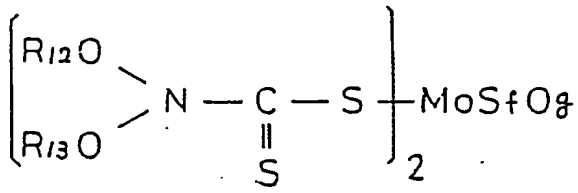
The amount of component [IV] to be added should be in the range of 0.1 -20 wt. %, preferably 1 -10 wt. %, based on the total composition. Smaller amounts than 0.1 wt. % would be ineffective for viscosity buildup. Greater amounts than 20 wt. % would lead to reduced traction coefficient.

Third and fourth embodiments of the invention are intended to make the resulting compositions more highly resistant to wear and longer in rolling fatigue life by further addition of selected molybdenum compounds.

Molybdenum compounds suitable as component [V] in the invention are one or more of molybdenum dithiophosphates and molybdenum dithiocarbamates represented respectively by the formulae



where R_{10} and R_{11} are alkyl, cycloalkyl, alkylcycloalkyl, aryl, alkylaryl or arylalkyl groups of 1 -24 carbon atoms, d is $0 < d \leq 4$, and e is $0 \leq e < 4$ in which $d + e = 4$, and



where R_{12} and R_{13} are as defined above, f is $0 < f \leq 4$, and g is $0 \leq g < 4$ in which $f + g = 4$.

Eligible R_{10} to R_{13} groups are methyl, ethyl, propyl, butyl, pentyl, hexyl, heptyl, octyl, nonyl, decyl, dodecyl, tetradecyl, hexadecyl, octadecyl, eicosyl, docosyl, tetracosyl, cyclopentyl, cyclohexyl, methylcyclohexyl, ethylcyclohexyl, dimethylcyclohexyl, cycloheptyl, phenyl, tolyl, xylyl, ethylphenyl, propylphenyl, butylphenyl, pentylphenyl, hexylphenyl, heptylphenyl, octylphenyl, nonylphenyl, decylphenyl, dodecylphenyl, tetradecylphenyl, hexadecylphenyl, octadecylphenyl, benzyl and phenethyl.

Specific examples of component [V] include molybdenum diethyldithiophosphate sulfide, molybdenum dipropyldithiophosphate sulfide, molybdenum dipropyldithiophosphate sulfide, molybdenum dibutyldithiophosphate sulfide, molybdenum dipentyldithiophosphate sulfide, molybdenum dihexyl-

dithiophosphate sulfide, molybdenum dioctyldithiophosphate sulfide, molybdenum didecyldithiophosphate sulfide, molybdenum didecyldithiophosphate sulfide, molybdenum di(butylphenyl)dithiophosphate sulfide, molybdenum(nonylphenyl)dithiophosphate sulfide, oxymolybdenum diethyldithiophosphate sulfide, oxymolybdenum dipropyldithiophosphate sulfide, oxymolybdenum dibutyldithiophosphate sulfide, oxymolybdenum dipentyldithiophosphate sulfide, oxymolybdenum dihexyldithiophosphate sulfide, oxymolybdenum dioctyldithiophosphate sulfide, oxymolybdenum didecyldithiophosphate sulfide, oxymolybdenum didodecyldithiophosphate sulfide, oxymolybdenum di(butylphenyl)dithiophosphate sulfide, oxymolybdenum di(nonylphenyl)dithiophosphate sulfide, molydbenum diethyldithiocarbamate sulfide, molybdenum dipropyldithiocaramate sulfide, molybdenum dibutyldithiocarbamate sulfide, molybdenum dihexyldithiocarbamate sulfide, molybdenum dioctyldithiocarbamate sulfide, molybdenum didecyldithiocarbamate sulfide, molybdenum didodecyldithiocarbamate sulfide, molybdenum di(butylphenyl)dithiocarbamate sulfide, molybdenum di(nonylphenyl)dithiocarbamate sulfide, oxymolybdenum diethyldithiocarbamate sulfide, oxymolybdenum dipropyldithiocarbamate sulfide, oxymolybdenum dibutyldithiocarbamate sulfide, oxymolybdenum dipentyldithiocarbamate sulfide, oxymolybdenum dihexyldithiocarbamate sulfide, oxymolybdenum dioctyldithiocarbamate sulfide, oxymolybdenum dioctyldithiocarbamate sulfide, oxymolybdenum didecyldithiocarbamate sulfide, oxymolybdenum didodecyldithiocarbamate sulfide, oxymolybdenum di(butylphenyl)dithiocarbamate sulfide and oxymolybdenum di(nonylphenyl)dithiocarbamate, and combinations thereof. Particularly preferred are combinations of phosphates, molybdenum dithiophosphates and molybdenum dithiocarbamates.

The amount of component [V] to be added should be in the range of 0.1 -10 wt. %, preferably 0.3 -5 wt. %, based on the total composition. Smaller amounts than 0.1 wt. % would fail to produce sufficient wear resistance and rolling fatigue life. Greater amounts than 10 wt. % would result in reduced traction coefficient and rolling fatigue life.

There may be used additives such as metallic cleaning agents including alkali metal sulfonates and alkaline earth metal sulfonates, anticorrosive agents, extreme pressure agents, viscosity index improvers, rust preventives and the like.

The invention will be further described by way of the following examples.

Inventive Examples 1 -8

Numerous tractive fluid compositions according to the invention were formulated and prepared as per Table 1.

Comparative Examples 1 -2

Two controls were prepared, one control using only a base oil of the invention, and the other being commercially available.

Performance test was made with the results shown in Table 2.

Dynamic Viscosity

Measurement was made in accordance with ASTM D 445 (Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids).

Traction Coefficient

Four-cylinder rolling friction tester was used with rolling speed 310 cm/second, load 90 kg/mm^2 and slip rate 2 %.

Oxidation Stability

JIS K 2514 (Testing Method for Oxidation Stability of Lubricants for Internal Combustion Engine Oils) was followed with temperature 165.5°C and time 72 hours. Viscosity ratio at 40°C was determined.

Shear Stability

Test was made in accordance with ASTM D 2603 (Standard Test Method for Sonic Shear Stability of Polymer-Containing Oils) with sonic radiation 10 KH_z, temperature 40°C and time 30 minutes. Viscosity reduction at 40°C was determined.

Wear Resistance

ASTM D 2266 was followed with speed 1,500 ppm, load 40 kgf and time 2 hours, using four balls. Wear scar diameter was measured.

Fatigue Life

IP 305 (Testing Method for Uni-Steel Rolling Fatigue) was followed. Length of time required for L_{10}:90 % life was measured.

Rust Prevention

This test was made in accordance with ASTM D 665 (Standard Test Method for Rust-Preventing Characteristics of Inhibited Mineral Oil in the Presence of Water).

It is to be noted that the compositions representing Inventive Examples 1 -8 are highly satisfactory in respect of all the performance characteristics tested. The controls of Comparative Examples 1 -2 were inadequate in wear resistance, fatigue life, shear stability and rust-proofness.

Table 1

Example	Formulation (wt. %)					
	base oil	component [I]	component [II]	component [III]	component [IV]	component [V]
Inventive Example 1	2,4-dicyclohexyl-2-methylpentane	zinc di-2-ethylhexyldithio phosphate (1.0)	alkenyl succinimide * (2.0)	sorbitan monolaurate (0.1)	--	--
Inventive Example 2	2,4-dicyclohexyl-2-methylpentane	zinc dinonylphenyldithiophosphate (2.0)	alkenyl succinimide boride (1.0)	sorbitan monooleate (0.1)	--	--
Inventive Example 3	bis(1-cyclohexylethyl)-dimethylcyclohexane	zinc diisopropyldithiophosphate (1.0)	alkenyl succinimide boride (1.0)	pentaerythritol monooleate (0.1)	--	--
Inventive Example 4	2,4-dicyclohexyl-2-methylpentane	zinc di-2-ethylhexyldithiophosphate (1.0)	alkenyl succinimide (1.0)	pentaerythritol monoisostearate (0.2)	polybutene A (4.0)	--
Inventive Example 5	2,4-dicyclohexyl-2-methylpentane	zinc didecyldithiophsphate (2.0)	alkenyl succinimide boride (1.0)	sorbitan monoisostearate (0.1)	ethylene-propylene copylymer (4.0)	--
Inventive Example 6	bis(1-cyclohexylethyl)-dimethylcyclohexane	zinc diisobutyldithiophosphate (1.0)	alkenyl succinimide (2.0)	pentaerythritol monolaurate (0.2)	polybutene B (8.0)	--

Table 1 (cont'd)

Example	Formulation (wt. %)					
	base oil	component [I]	component [II]	component [III]	component [IV]	component [V]
Inventive Example 7	2,4-dicyclohexyl-2-methylpentane	zinc diisopropyldithiophosphate (1.0)	alkenyl succinimide boride (1.0)	sorbitan monolaurate (0.1)	--	oxymolybdenum di(2-ethylhexyl)dithiophosphate (0.3)
Inventive Example 8	2,4-dicyclohexyl-2-methylpentane	zinc dinonylphenyldithiophosphate (2.0)	alkenyl succinimide boride (1.0)	pentaerythritol monoisostearate (0.2)	polybutene A (4.0)	oxymolybdenum dibutyldithiocarbamate (0.5)
Comparative Example 1	2,4-dicyclohexyl-2-methylpentane	--	--	--	--	--
Comparative Example 2	commercial product					

* alkenyl succinimide: compound derived by reaction of polyisobutylene (molecular weight 1,000) substituted succinic anhydride with N-octadecyltrimethylenediamine

* alkenyl succinimide boride: compound derived by reaction of polyisobutylene (molecular weight 1,000) substituted succinic anhydride with N-octadecyltrimethylenediamine and boric acid

* polybutene A: average molecular weight 2,700

* polybutene B: average molecular weight 1,350

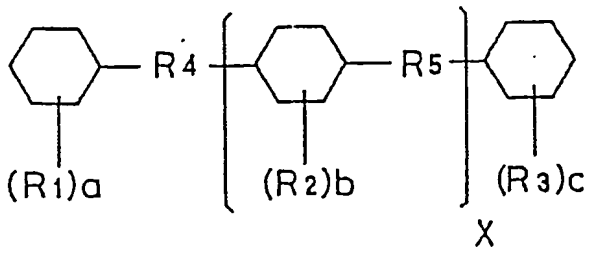
* ethylene-propylene copolymer: average molecular weight 3,700

Table 2

Example	Performance						
	dynamic viscosity (cSt, @40°C)	traction coefficient	oxidation stability (viscosity ratio, @40°C)	shear stability (viscosity reduction, @40°C)	wear resistance (wear scar diameter, mm)	fatigue life (L_{10}, hr)	rust-proofness
Inventive Example 1	21.0	0.087	1.0	0.0	0.53	7.2	rustless
Inventive Exampel 2	20.9	0.088	1.0	0.0	0.57	7.0	"
Inventive Example 3	20.9	0.087	1.0	0.0	0.55	7.3	"
Inventive Example 4	30.2	0.088	1.0	0.1	0.41	8.3	"
Inventive Example 5	32.5	0.087	1.0	0.1	0.60	8.2	"
Inventive Example 6	31.6	0.087	1.0	0.1	0.46	8.4	"
Inventive Example 7	21.0	0.087	1.2	0.0	0.51	9.1	"
Inventive Example 8	30.1	0.087	1.0	0.1	0.40	9.0	"
Comparative Example 1	20.6	0.086	1.2	0.0	0.76	6.5	extremely rusted
Comparative Example 2	29.7	0.086	1.2	14.2	1.45	7.3	"

Claims

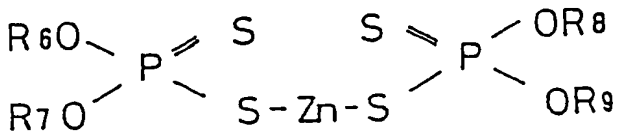
1. A lubricant composition for use in traction drives comprising: a base oil represented by the formula



where R_1, R_2 and R_3 are alkyl groups of 1 -4 carbon atoms, R_4 and R_5 are methylene, ethylene or trimethylene groups which may be substituted at the carbon atoms with an alkyl group of 1 -4 carbon atoms, a, b and c are integers of 0 -2, and x is an integer of 0 or 1; [I] a zinc dialkyldithio phosphate in an amount of 0.1 -5 wt. %; [II] an alkenyl succinimide or its boron derivatives in an amount of 0.1 - 5 wt. %; and [III] a carboxylic acid partial ester of a polyalcohol of 3 -6 carbon atoms in an amount of 0.01 -5 wt. %, each said amount being based on the total composition.

2. The lubricant composition according to claim 1 wherein said base oil is selected from the group consisting of dicyclohexylmethane 1,1-dicyclohexylethane, 1,2-dicyclohexylethane, 1,2-dicyclohexyl propane, 1,3-dicyclohexylpropane, 2,2-dicyclohexylpropane, 1,2-dicyclohexyl-2-methylpropane, 1,3-dicyclohexylbutane, 1,3-dicyclohexyl-3-methylbutane, 1,3-dicyclohexyl-2,3-dimethylbutane, 2,3-dicyclohexyl2,3-dimethylbutane, 2,4-dicyclohexylpentane, 2,4-dicyclohexyl-2-methylpentane, bis-(cyclohexylmethyl)cyclohexane, bis(1-cyclohexylethyl)cyclohexane and bis(1-methyl-2-cyclohexylethyl)cyclohexane, substituted compounds thereof in which one or two methyl or ethyl groups are bonded to the carbon atoms of the cyclohexyl ring, and combinations thereof.

3. The lubricant composition according to claim 1 wherein said component [I] is a compound represented by the formula



where R_6, R_7, R_8 and R_9 are alkyl or alkylaryl groups of 3 -22 carbon atoms, and may be the same or different.

4. The lubricant composition according to claim 1 wherein said component [II] is an alkenyl succinimide resulting from the reaction of a polyolefin of 2 -30 carbon atoms with maleic anhydride, followed by conversion of the resulting reaction product into an imide form by reaction with an amine.

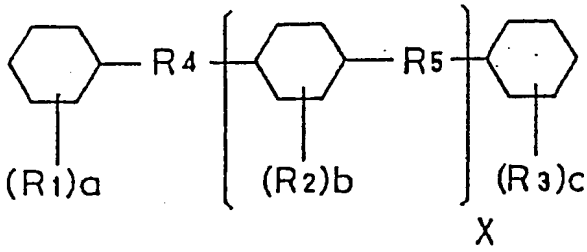
5. The lubricant composition according to claim 4 wherein said polyolefin is selected from the group consisting of homopolymers and copolymers of ethylene, propylene, butene, pentene, hexene, heptene, octene, nonene, decene and dodecene, and copolymers thereof with styrene, and said amine is selected from the group consisting of methylamine, ethylamine, propylamine, butylamine, pentylamine, hexylamine, heptylamine, octylamine, ethylenediamine, propylenediamine, N,N'-dimethylpropylenediamine, trimethylenediamine, N,N'-dihexyltrimethylenediamine, decamethylenediamine, di(trimethylene)triamine, di-(heptamethylene)triamine, triethylenetetraamine, tripropylenetraamine, tetraethylenepentaamine, pentaethylenehexaamine, imidazoline, methylimidazoline, bis(aminoethyl)imidazoline,

pyrimidine, aminopropylpiperazine, bis(aminoethyl)-piperazine, N-mono(hydroxyethyl)ethylenediamine, N,N'-bis(hydroxyethyl)ethylenediamine, N-mono-(hydroxypropyl)diethylenetriamine and N,N'-bis-(hydroxypropyl)tetraethylenepentaamine.

6. The lubricant composition according to claim 4 wherein said component [II] is a compound derived by reaction of said alkenyl succinimide with a boron compound selected from the group consisting of boron oxide, boron oxide hydrates, boron trifluoride, boron trichloride, boron tribromide, alkyl borons, aryl borons, boric acid, metaboric acid and tetraboric acid, and esters of said boric acids with alcohols and phenols and ammonium salts thereof.

7. The lubricant composition according to claim 1 wherein said component [III] is selected from the group consisting of glycerine dodecanoic acid monoester, glycerine hexadecanoic acid monoester, glycerine octadecanoic acid monoester, glycerine octadecenoic acid monoester, pentaerythritol dodecanoic acid monoester, pentaerythritol hexadecanoic acid monoester, pentaerythritol octadecanoic acid monoester, pentaerythritol octadecenoic acid monoester, sorbitol dodecanoic acid monoester, sorbitol hexadecanoic acid monoester, sorbitol octadecanoic acid monoester, sorbitol octadecenoic acid monoester, sorbitan dodecanoic acid monoester, sorbitan hexadecanoic acid monoester, sorbitan octadecanoic acid monoester, sorbitan octadecenoic acid monoester, sorbitan octadecanoic acid triester and sorbitan octadecenoic acid triester and combinations thereof.

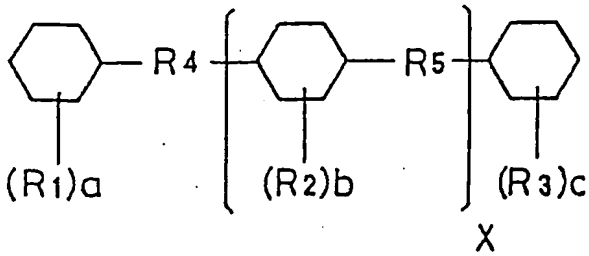
8. A lubricant composition for traction drives comprising: a base oil represented by the formula



where R_1, R_2 and R_3 are alkyl groups of 1 -4 carbon atoms, R_4 and R_5 are methylene, ethylene or trimethylene groups which may be substituted at the hydrogen atoms with an alkyl group of 1 -4 carbon atoms, a, b and c are integers of 0 -2, and x is an integer of 0 or 1; [I] a zinc dialkyldithio phosphate in an amount of 0.1 -5 wt. %; [II] an alkenyl succinimide or its boron derivative in an amount of 0.1 -5 wt. %; [III] a carboxylic acid partial ester of a polyalcohol of 3 -6 carbon atoms in an amount of 0.01 -5 wt. %; and [IV] a polyolefin in an amount of 0.1 -20 wt. %, said polyolefin resulting from the homo-or co-polymerization of olefins of 2 -8 carbon atoms and having an average molecular weight of 200 -10,000, each said amount being based on the total composition.

9. The lubricant composition according to claim 8 wherein said component [IV] is selected from the group consisting of polybutene, polyisobutylene, ethylenepropylene copolymer, ethylene-1-butene copolymer and ethylene-propylene-1-butene copolymer.

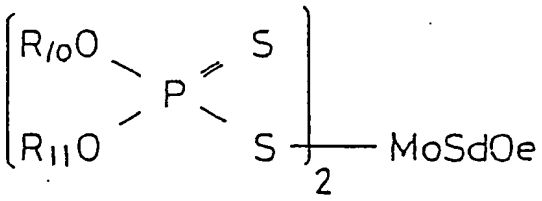
10. A lubricant composition for traction drives comprising: a base oil represented by the formula



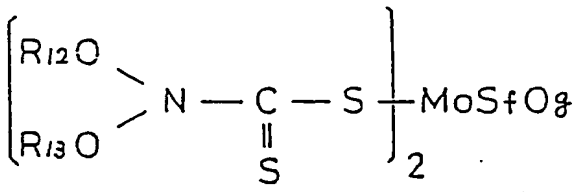
where R_1, R_2 and R_3 are alkyl groups of 1 -4 carbon atoms, R_4 and R_5 are methylene, ethylene or trimethylene groups which may be substituted at the hydrogen atoms with an alkyl group of 1 -4 carbon atoms, a, b and c and integers of 0 -2, and x is an integer of 0 or 1; [I] a zinc dialkyldithio

phosphate in an amount of 0.1 -5 wt. %; [II] an alkenyl succinimide or its boron derivative in an amount of 0.1 -5 wt. %; [III] a carboxylic acid partial ester of a polyalcohol of 3 -6 carbon atoms in an amount of 0.01 -5 wt. %; and [V] at least one of molybdenum dithiophosphates and molybdenum dithiocarbamates in an amount of 0.1 -10 wt. %, each said amount being based on the total composition.

11. The lubricant composition according to claim 11 wherein said component [V] is a molybdenum dithiophosphate represented by the formula



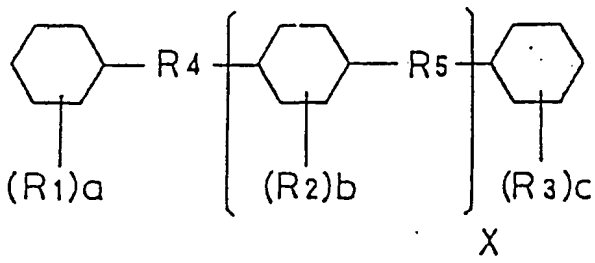
where R_{10} and R_{11} are alkyl, cycloalkyl, alkylcycloalkyl, aryl, alkylaryl or arylalkyl groups of 1 -24 carbon atoms, d is 0 d 4, and e is 0 e 4 in which d + e = 4, and/or a molybdenum dithiocarbamate represented by the formula



where R_{12} and R_{13} are as defined above, f is 0 f 4, and g is 0 g 4 in which f + g = 4.

12. The lubricant composition according to claim 11 wherein said component [V] is selected from the group consisting of molybdenum diethyldithiophosphate sulfide, molybdenum dipropyldithiophosphate sulfide, molybdenum dipropyldithiophosphate sulfide, molybdenum dibuthyldithiophosphate sulfide, molybdenum dipentyldithiophosphate surfide, molybdenum dihexyldithiophosphate sulfide, molybdenum dioctyldithiophospohate sulfide, molybdenum didecyldithiophosphate sulfide, molybdenum didodecyldithiophosphate sulfide, molybdenum di-(butylphenyl)dithiophosphate sulfide, molybdenum (nonylphenyl)dithiophosphate sulfide, oxymolybdenum diethyldithiophosphate sulfide, oxymolybdenum dipropyldithiophosphate sulfide, oxymolybdenum dibutyldithiophosphate sulfide, oxymolybdenum dipentyldithiophosphate sulfide, oxymolybdenum dihexyldithiophosphate sulfide, oxymolybdenum dioctyldithiophosphate sulfide, oxymolybdenum didecyldithiophosphate sulfide, oxymolybdenum didodecyldithiophosphate sulfide, oxymolybdenum di(butylphenyl)dithiophosphate sulfide, oxymolybdenum di(nonylphenyl)-dithiophosphate sulfide, molybdenum diethyldithiocarbamate sulfide, molybdenum dipropyldithiocarbamate sulfide, molybdenum dibutyldithiocarbamate sulfide, molybdenum dihexyldithiocarbamate sulfide, molybdenum dioctyldithiocarbamate sulfide, molybdenum didecyldithiocarbamate sulfide, molybdenum didodecyldithiocarbamate sulfide, molybdenum di-(butylphenyl)dithiocarbamate sulfide, molybdenum di(nonylphenyl)dithiocarbamate sulfide, oxymolybdenum diethyldithiocarbamate sulfide, oxymolybdenum dipropyldithiocarbamate sulfide, oxymolybdenum dibutyldithiocarbamate sulfide, oxymolybdenum dipentyldithiocarbamate sulfide, oxymolybdenum dihexyldithiocarbamate sulfide, oxymolybdenum dioctyldithiocarbamate sulfide, oxymolybdenum dioctyldithiocarbamate sulfide, oxymolybdenum didecyldithiocarbamate sulfide, oxymolybdenum didodecyldithiocarbamate sulfide, oxymolybdenum di(butylphenyl)dithiocarbamate sulfide and oxymolybdenum di(nonylphenyl)-dithiocarbamate, and combinations thereof.

13. A lubricant composition for traction drives comprising: a base oil represented by the formula



where R_1, R_2 and R_3 are alkyl groups or 1 -4 carbon atoms, R_4 and R_5 are methylene, ethylene or trimethylene groups which may be substituted at the hydrogen atoms with an alkyl group of 1 -4 carbon atoms, a, b and c are integers of 0 -2, and x is an integer of 0 or 1; [I] a zinc dialkyldithio phosphate in an amount of 0.1 -5 wt. %; [II] an alkenyl succinimide or its boron derivative in an amount of 0.1 -5 wt. %; [III] a carboxylic acid partial ester of a polyalcohol of 3 -6 carbon atoms in an amount of 0.01 -5 wt. %; [IV] a polyolefin in an amount of 0.1 -20 wt. %, said polyolefin resulting from the homo-or co-polymerization of olefins of 2 -8 carbon atoms and having an average molecular weight of 200 - 10,000; and [V] at least one of molybdenum dithiophosphates and molybdenum dithiocarbamates in an amount of 0.1 -10 wt. %, each said amount being based on the total composition.